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Development of X-ray Photon Correlation Spectroscopy in the Ultrasmall-angle X-ray Scattering Scale and Time Regime

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Over the last decade the ultrasmall-angle x-ray scattering (USAXS) instrument at the Advanced Photon Source has been continually upgraded and has become a world-class instrument for materials research. Meanwhile, x-ray photon correlation spectroscopy (XPCS) has emerged as a measurement technique that offers unprecedented sensitivity to the dynamics of structural changes in materials. However, existing XPCS facilities are limited to microstructure length scales smaller than ~50 nm, thus eliminating large classes of materials that are of major technological importance. Recently, the range of this technique has been extended dramatically by combining XPCS speckle measurements with USAXS studies at the Advanced Photon Source. While USAXS characterizes microstructures over the nanometer-to-micrometer scale range, use of a small entrance slit allows the coherence of the undulator x-ray beam to be exploited to give synergistic XPCS measurements of internal microstructure dynamics. At the large end of the scale range, the correspondingly slower dynamics are well matched to USAXS scan times. Progress in XPCS/USAXS development will be demonstrated with reference both to well-characterized colloidal dispersions and to composite systems for biomedical applications.

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